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FALL AND WINTER FOOD HABITS OF DEER IN NORTHEASTERN MINNESOTA

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WINTER FOOD SUPPLY

The northern white-tailed deer (Odocoileus virginianus borealis) is depleting its winter food supply in the Lake States region to such an extent as to create a situation that, if not corrected, will have disastrous effects on the animals themselves. The available winter food supply is a limiting factor on the deer populations in areas where the animals are greatly restricted in movements by extreme cold weather and heavy snows. Under such conditions the deer often eat the choice foods early in winter and then are compelled to subsist upon less nutritious plants when their physical condition is poorest.

In parts of northeastern Minnesota, fires and logging activities in the past have improved general conditions for deer, but they have also greatly reduced winter cover, especially white cedar and other conifers, and have forced the deer to retreat into the remaining clumps of evergreens for winter protection. Because of the small size of many of these yarding islands and the heavy concentrations of deer using them, the food supply is often insufficient. The area here reported on lies between Lake Superior and United States Highway No. 53 from Duluth to International Falls, Minn.

STOMACH ANALYSES

To ascertain the choice food plants and the species eaten during the critical period, two series of deer stomachs were collected and the contents analyzed. 1/ Twenty-one stomachs were taken from deer killed during the 1936 hunting season, when the animals were in excellent physical condition and had access to a wide variety of foods. Late in the winter of 1936-37, 51 stomachs were collected from deer that had starved, or had been killed by predators or automobiles, or had died from pneumonia or exposure. Eight of the 21 fall stomachs were taken from the Kabetogoma State Forest, near Ray, Minn., and the remaining 13 from the Superior National Forest, near Ely, Minn. The winter stomachs were taken from areas as follows: 12 from the Cloquet Valley State Forest, near Brimson, Minn., and 39 from the Superior National Forest. Of the latter, all were taken from the eastern border of the forest: 5 from the Temperance deeryard, 2 from the Gunflint district, and 18 from the Jonvick deeryard. The remaining 14 were taken near Ely, Minn., in the same general area as the fall stomachs from the Superior National Forest.

The percentages by volume of the more important foods in the two series of stomachs are shown in figure 1. It will be noted that during the fall, plants of the willow family (Salicaceae) were eaten in greatest quantity, forming 29 percent of the total, but late in winter they dropped to 3.8 percent. Members of this group in the fall food were quaking aspen (Populus tremuloides) and balsam poplar (P. balsamifera), 17.4 percent, and willows (Salix spp.), 11.4 percent. Late in winter only willow was found.

Balsam fir (Abies balsamea), which formed 13.4 percent of the total, ranked second in the quantity of food eaten in fall. Feeding experiments conducted in New York 2/ and Michigan 3/ indicate that balsam as the sole food, or in too large proportion even when taken with others, does not maintain deer in a strong physical condition. That balsam is a starvation diet is illustrated in the present study by the quantity found in the stomachs of deer that died late in winter, when the plant ranked first and formed 42.7 percent of the food. Balsam formed 80 percent or more of the contents of 17, or a third, of the stomachs, 5 of which held nothing else. When there is a choice, deer may feed on balsam frequently but only lightly in comparison with the quantity taken when choice foods are not available. Even though the volume consumed in fall was less than one-third of that eaten late in winter, the percentage of the total number of deer feeding upon balsam was higher--86 compared with 80 (fig. 2).

1/ Stomach examinations were made by the junior author in the Food Habits Laboratory at Washington.

2/ Maynard, L. A.; Bump, Gardiner; Darrow, Robert; and Woodward, J. C., Food Preferences and Requirements of the White-tailed Deer in New York State. Joint contribution of the New York State Conservation Department and the New York State College of Agriculture. 35 pp. 1935.

3/ Davenport, L. A., Find Deer Have Marked Food Preferences. Mich. Conserv. 7 (4): 4-5, 6, 11. 1937.

Pine is usually assumed to have about the same nutritive value as balsam. During the fall it was eaten by 73 percent of the animals and formed 7 percent of the total food. Late in winter the number of deer eating pine dropped to 33 percent, but the quantity consumed doubled (14 percent). Jack pine (*Pinus banksiana*) was found in 54 percent of the fall stomachs, white pine (*P. strobus*) in 18, and red pine (*P. resinosa*) in 14. Jack pine occurred in 10 percent of the late-winter stomachs, white pine in 22, and red pine in 16.

White cedar (*Thuja occidentalis*), generally considered one of the best deer foods, was found in 23 percent of the fall stomachs and formed 9 percent of the total food. The quantity consumed increased to 13 percent during the winter, when it was found in 39 percent of the stomachs. This figure represents the maximum utilization of this food and indicates strenuous effort on the part of the deer to obtain it, for much of it was available to the animals only after heavy snows raised their browsing reach. Some of the cedar eaten from one "yard" was that lopped off to feed the animals during a critical period.

Spruce (in this region chiefly black spruce [*Picea mariana*]) is not an important deer food and is not eaten in large quantities until conditions are severe. It formed only 0.7 percent of the food in fall and 2 percent in winter. Even though not taken in quantity, it was eaten frequently and was found in 32 percent of the fall and 33 percent of the winter stomachs.

The birch family was represented in the diet by paper birch (*Betula papyrifera*), alder (*Alnus sp.*), beaked hazelnut (*Corylus rostrata*), and hophornbeam (*Ostrya virginiana*). Paper birch was by far the most important of these species and was noted most frequently and in greatest quantity. Alder was found in only one winter and four fall stomachs, while hazelnut and hophornbeam were each noted once in the fall stomachs. Although the birch family occurred in 59 percent of the fall stomachs and formed 10 percent of the volume, it was present in only 25 percent of the winter stomachs and comprised 4 percent of the total food.

Members of the heath family (Ericaceae) eaten by deer were wintergreen (*Gaultheria procumbens*), Labrador-tea (*Ledum groenlandicum*), and leatherleaf (*Chamaedaphne calyculata*). These plants were selected by 23 percent of the deer in fall and by 12 percent in winter and formed 5 and 3 percent, respectively, of the total volume. Being unavailable after deep snows, these low plants were eaten less frequently in winter.

The honeysuckle family (Caprifoliaceae) was represented in the fall diet of the deer by the twinflower (*Linnaea borealis*), which occured in 14 percent of the stomachs but formed only a trace (i.e. less than 1 percent) of the total food, and in the winter diet by viburnum, which was found in 10 percent of the stomachs and composed 5 percent of the total food.

Bunchberry (*Cornus canadensis*) occurred in 27 percent of the fall stomachs and formed 2.2 percent of their contents by volume. In the winter series, dogwood (*Cornus* sp.) was found in only one stomach and formed less than 1 percent of the total food of the deer. Field observations would indicate that this dogwood was probably red-osier (C. stolonifera), as it is the most common species in this area that would be available above deep snows. Its low use by deer might be interpreted to mean that it is uncommon or unpalatable, but neither is the case. This species is moderately common in the areas where the winter stomachs were collected and had been browsed heavily by deer. Although it is one of the favored deer foods, the available supply was small and was removed early in the year, before the stomachs representing this study were collected.

Species of the rose family (Rosaceae) were found in 27 percent of the fall and 4 percent of the winter stomachs and formed 3 percent by volume of the former and less than 1 percent of the latter. The family was represented by raspberry, cherry, strawberry, rose, and spiraea.

Club mosses, lichens, and fungi combined were found in 36 percent of the fall stomachs and represented 2.2 percent of the volume eaten. In the winter series one occurrence of lichen represents this group.

Grasses (Gramineae) appeared in 27 percent of the fall and 23 percent of the winter stomachs and formed 2 percent of the volume in each series. Sedges (Cyperaceae) were found in only one fall stomach.

All the foods found in the examined stomachs (including those eaten in too small a quantity to form 1 percent by volume) are listed in table 1.

Some of the stomach contents were too finely masticated for positive identification, and these were divided into two groups: Items that could be identified only as seed plants (angiosperms), which formed 10.7 percent of the fall and 3.5 percent of the winter food, and other unidentified items, which formed 3 percent of the winter food.

FIELD OBSERVATIONS

The feeding experiments in Michigan[4/] showed that white cedar is the only native browse that fed alone will support deer in winter. To supply the required nutrients, all other browse species had to be fed in larger quantities and in combination with cedar or with a variety of other plants. The results of the experiments emphasize the difficulties faced by deer in winter. Not only is food in general more scarce at that season, but with most of the white cedar gone, other foods must be found in greater quantity.

Reduction in the variety of food available in winter is indicated, as shown in table 1, by the contents of the deer stomachs on which this study is based. Necessarily, therefore, the deer had to eat larger quantities of the species available at that time, and if the nutritional value of these foods was less, the quantity needed to sustain life might be greatly

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[4/] See footnote 3, page 2.

increased. The problem of supplying adequate winter browse for large deer herds is no easy one. For example, if conditions for white cedar, one of the best deer foods, are to be improved, depleted stands could be fenced off for its protection, but the cost might be prohibitive. If white cedar cannot be reproduced or grown in the wintering areas, the number of deer would have to be reduced.

The results of a survey made by the United States Forest Service of the available browse in 19 deeryards in the Superior National Forest[5/] are an aid in interpreting the findings in the present study. Data obtained in that survey as to availability of the most common browse species, expressed in percentage of total pounds of browse available, is the basis of figure 3. To show the great differences in browse conditions between various sections of the forest, two individual deeryards also are compared.

Olson's figures, as well as the senior author's observations, show that balsam fir is abundant and available in most of the deeryards in the Superior Forest. In the Jonvick yard it is very abundant and of a size small enough to be available, while in the Temperance yard the trees are larger and not so much browse is within reach of the deer.

Spruce is an important cover species over most of the Superior Forest and is largely available for browsing, but in the Jonvick and Temperance yards the trees are of value chiefly for cover, as they are so tall and clean-boled as to supply little food.

Field studies reveal that pine forms only a fraction of 1 percent of the available food and that it occurs mainly outside of the yarding areas. Pine formed no part of the food of the deer taken from the two yards individually represented in the graph, but it did occur in stomachs of deer taken in areas where the animals yarded little or not at all.

Some cedar is still available in most of the yards, but very little is within reach of the deer in the Jonvick and Temperance yards, although much of the yarding cover in both areas is composed of mature trees of this species. White cedar is reproducing but, being cropped by a herd of heavily concentrated animals, never gets above the snow line.

Alder is abundant in most of the yards of the Superior Forest but is rarely found in the Jonvick area. This species is seldom eaten in fall and is browsed in winter only after other deer foods are exhausted.

Most of the birch within the yards is of tree size, thus little is available to deer. On the uplands and old burns this species is often abundant, but in winter such areas are not frequented by the deer. Dwarf, yellow, and paper birches occur, but only the last is common enough in this area to be an important food.

[5/] Olson, Herman F., An Analysis and Interpretation of Deer Study Data on Superior National Forest, 1934-37, inclusive. Typed report dated October 15, 1937, filed in the office of the United States Forest Service, Duluth, Minn.

Aspen and willow seem to occupy areas that are better drained than those usually used by deer for yards. In northeastern Minnesota, aspen appears to be more dominant in wet places than willow.

Red-osier is the most common dogwood species that supplies winter browse. This shrub is abundant in small patches but rarely covers any extensive area. When found where the deer concentrate it is browsed heavily during the early winter months. It suckers abundantly, but has been browsed so heavily in the Jonvick yard that the annual growth is declining there.

Field observations have shown that maple brush is among the more important of the deer browse species in the Superior National Forest. Along the northern shore of Lake Superior, the mountain maple (Acer spicatum) is the most abundant form, while over the western two-thirds of the forest the red maple (A. rubrum) is dominant. Both these species, however, occur over the entire area. They areamong the first to be browsed and are usually depleted earlier in the year. The mountain maple is commonly associated with white cedar, but the red maple grows on higher and better-drained soils. Figure 3 shows the availability of maple as a browse species throughout the forest. It suckers profusely and even under extreme browsing usually makes a good annual growth. The mountain maple is one of the principle browse species in the Jonvick yard, yet it was not found in any of the 18 winter stomachs from that area. The explanation is, as mentioned above, that all that was available was eaten earlier in the year.

The beaked hazelnut is well distributed throughout the Superior Forest but usually occurs on upland areas and therefore is not so common where the deer concentrate in winter. One exception, however, is the abundance of this species in the Temperance yard, which is different from all others in the forest in that it comprises a hilly area on both sides of the Temperance River and has a mature but thin stand of mixed hardwoods, cedar, balsam fir, and spruce, and a luxuriant growth of brush. Because the annual output of twigs on the hazelnut is small and the plant grows largely outside the yards, it is not of great importance to deer in winter.

Mountain-ash (Sorbus americana) is a splendid deer food but, as indicated in figure 3, is not readily available. Two distinct groups of this plant are in the area: (1) Those above the reach of deer; and (2) those that never get above the snow line because of browsing. On some of these the deer had eaten twigs up to three-eighths of an inch in diameter.

Red elderberry (Sambucus racemosa) is a choice deer food but is not available in sufficient quantity to be of much value in winter.

In the 19 deeryards studied on the Superior National Forest, the following plants were available in quantities too small to be considered important as potential winter deer foods: Tamarack, honeysuckle, thimbleberry, black ash, jack pine, pin cherry, and juneberry.

SURVEY OF THE JONVICK YARD

To learn which of the available species were being eaten, a browse-utilization survey was made in the Jonvick yard early in May 1936. This was done after the yarding season, so it represents the browse eaten throughout the winter period. One hundred and twenty plots, each 0.01 acre in size, were surveyed for the species present and for degree of browsing. These were located on lines at 5-chain intervals so that no element of human choice affected their selection. Availability in each case was considered to be any succulent twigs of hardwoods or leafy parts of conifers that were within 7 feet of the ground. Grasses, sedges, and ground forms were not recorded, because they were usually too far beneath the snow during the yarding season to be important to deer. The results of this survey, shown in table 2, indicate clearly the species that are important as food in this yard.

Mountain maple, because of its abundance and heavy utilization by deer, was the most important browse species present.

Thimbleberry and honeysuckle showed a high frequency of browsing but these species are more available after the snow begins to recede in spring. Because only the terminal buds of the thimbleberry and a small part of the annual growth of the honeysuckle were eaten, the actual quantity of food obtained from these species was rather small, but it was available in time of need.

Paper birch, red-osier dogwood, mountain-ash, and black ash were heavily browsed, but their availability was so low that they are of little importance to deer in this yard.

Balsam fir was found in a large percentage of the plots, and many of the trees had been browsed lightly. The aggregate feeding in so many places, however, makes balsam one of the dominant foods.

Although white cedar was found on 32 percent of the plots, in each it was represented by only a few limbs that deer could reach from crusted snow or by recumbent branches that were available only after the snow had receded. The browsing was therefore very light and actually provided very little food.

CONCLUSIONS

1. Stomach analyses and available-browse surveys indicate that the winter carrying capacity for deer in northeastern Minnesota is declining.

2. The browse species that form the greater part of the winter food are those now most available but not those of greatest nutritive value.

3. Many of the choice browse species are either uncommon or are becoming unavailable because of heavy browsing in previous years.

4. Balsam fir may be good deer browse when eaten in moderate quantity in combination with more nutritious foods, but when taken alone or in too great a proportion to other foods it is not capable of maintaining the deer in good health.

5. Maple brush is the most available of the choice browse species in this area. Other kinds may be locally abundant but are not generally distributed.

6. Variation in availability of certain browse species in the different deer concentration grounds indicates that management practices must be developed for limited areas.

TABLE 1.--List of food items found in 72 stomachs of white-tailed deer collected in northeastern Minnesota in fall and late in winter

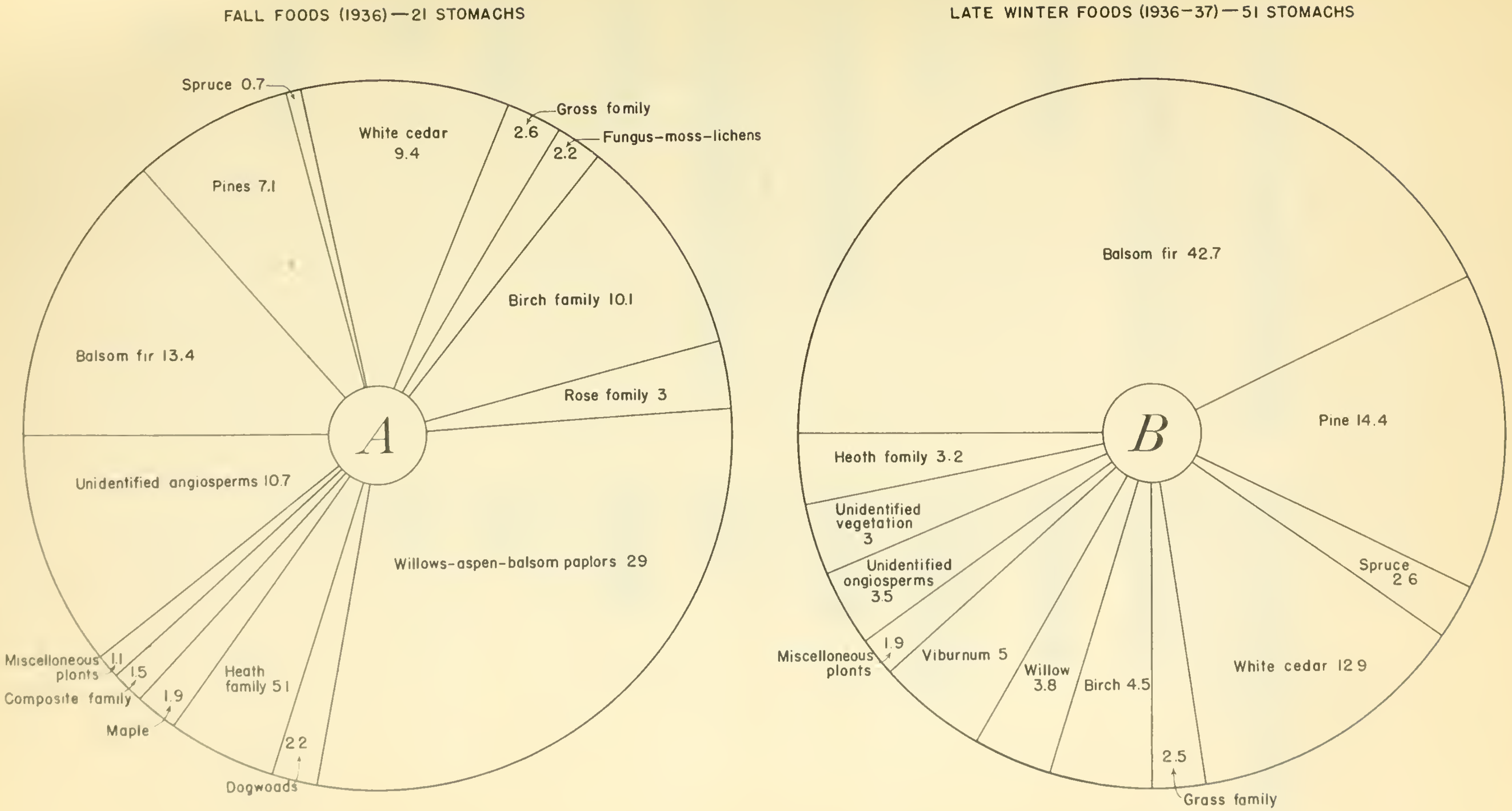
Food items	Fall stomachs		Winter stomachs	
	Occurrences	Parts eaten	Occurrences	Parts eaten
	Number		Number	
Alder (*Alnus* sp.)	5	Twigs, leaves	1	Twigs
Aspen, quaking (*Populus tremuloides*).	11	Leaves, twigs	. . .	
Basswood (*Tilia americana*). .	2	Bract	. . .	
Birch, undet. (*Betula* sp.). .	1	Leaves	3	Buds, twigs, leaf debris, bark.
Birch family (Betulaceae) . .	. . .	. . . .	1	Twigs.
Birch, paper (*Betula papyrifera*).	10	Twigs, leaves	8	Twigs, leaves.
Bunchberry (*Cornus canadensis*).	6	Leaves, twigs	. . .	
Cedar, white (*Thuja occidentalis*).	5	. . do . . .	20	Leaves, twigs.
Cherry, pin (*Prunus pennsylvanica*).	1	Leaves, fruit	. . .	
Cherry, wild (*Prunus* sp.) . .	1	Twigs	2	Twigs
Clover (*Trifolium* sp.). . . .	1	Leaves	. . .	
Composite family (Compositae)	2	. . do . . .	. . .	
Dogwood (*Cornus* sp.).	. . .	. . . .	1	Leaves.
Elm, American (*Ulmus americana*).	1	Seeds	. . .	
Fir, balsam (*Abies balsamea*).	19	Leaves	41	Twigs, leaves.
Fungus (shelf type)	3	Sporophore	. . .	
Gall	1	. . . .	. . .	
Goldenrod (*Solidago* sp.). . .	2	Leaves	. . .	
Grape (*Vitis* sp.)	1	. . do . . .	. . .	
Grapefern (*Botrychium* sp.). .	1	. . do . . .	. . .	
Grass (Gramineae)	6	. . do . . .	12	Leaves, stems.
Groundpine (*Lycopodium obscurum*).	1	Tip	. . .	

TABLE 1.--List of food items found in 72 stomachs of white-tailed deer collected in northeastern Minnesota in fall and late in winter--Continued.

Food items	Fall stomachs		Winter stomachs	
	Occurrences	Parts eaten	Occurrences	Parts eaten
	Number		Number	
Hardhack (*Spiraea tomentosa*).	1	Leaves	. . .	
Hazelnut, beaked (*Corylus rostrata*).	1	. . do	. . .	
Hophornbeam, American (*Ostrya virginiana*).	1	. . do . . .	. . .	
Juniper (*Juniperus* sp.). . .	2	. . do . . .	. . .	
Labrador-tea (*Ledum groenlandicum*).	5	. . do . . .	4	Leaves.
Leatherleaf (*Chamaedaphne calyculata*).	. . .	. . . .	1	Do.
Lichen (foliose)	3	. . . . . .	1	
Loosestrife (*Steironema* sp.)	1	Leaves	. . .	
Maple, red (*Acer rubrum*) . .	2	Samara, leaves twigs.	. . .	
Maple, undet. (*Acer* sp.) . .	1	Buds	1	Twigs, buds.
Moss	. . .	. . . .	1	
Oak, red (*Quercus borealis*).	1	Leaves	2	Leaves.
Pine, jack (*Pinus banksiana*)	12	Needles	4	Needles.
Pine, red (*Pinus resinosa*) .	3	. . do . . .	7	Do.
Pine, white (*Pinus strobus*).	4	. . do . . .	12	Needles, twigs.
Pine, undet. (*Pinus* sp.) . . .	1	. . do . . .	. . .	
Poplar, balsam (*Populus balsamifera*).	3	Leaves, twigs	. . .	
Poplar, undet. (*Populus* sp.)	5	. . do . . .	. . .	
Raspberry (*Rubus* sp.). . . .	3	Leaves	3	Leaves.
Rose (*Rosa* sp.).	1	Leaves, twigs	1	Twigs.
Rose family (Rosaceae) . . .	1	Leaves	. . .	
Sedge family (Cyperaceae). .	1	. . do . . .	. . .	
Sheep sorrel (*Rumex acetosella*).	1	. . do . . .	. . .	
Spruce (*Picea* sp.)	7	Needles	17	Needles.
Strawberry (*Fragaria* sp.). .	1	Leaves	1	Leaves.
Twinflower (*Linnaea borealis*)	3	. . do . . .	. . .	
Viburnum (*Viburnum* sp.). . .	. . .	. . . .	3	Twigs
Willow (*Salix* sp.)	7	Leaves, twigs	6	Do.
Wintergreen (*Gaultheria procumbens*).	. . .	. . . .	1	Leaves.

TABLE 2.--Availability of browse species in the Jonvick deeryard and their use by deer in winter as determined by observations on 120 plots

Species	Plots in which plants were present	Plants browsed	Degree of browsing	Parts eaten
	Percent	Percent		
Balsam fir (*Abies balsamea*).	92	62	Light	A few tips.
Mountain maple (*Acer spicatum*).	85	96	Heavy	Most of annual growth.
Honeysuckle (*Lonicera* sp.)	45	78	Medium	Those exposed by snow.
White cedar (*Thuja occidentalis*).	32	61	Light	Mostly confined to low individuals browsed after snow receded.
Thimbleberry (*Rubus* sp.)	26	97	. . do . .	Terminal buds, mostly after snow receded.
Paper birch (*Betula papyrifera*).	9	64	Heavy	Most of annual growth; occurs chiefly as suckers from old stumps.
Black ash (*Fraxinus nigra*)	4	100	. . do . .	All the annual growth.
Red-osier dogwood (*Cornus stolonifera*).	4	83	. . do . .	Do.
Alder (*Alnus* sp.).	4	60	Light	A few odd twigs.
Mountain-ash (*Sorbus americana*).	2	100	Very heavy	All the annual growth, sometimes more.
Beaked hazelnut (*Corylus rostrata*).	2	50	Medium	About half the annual growth.
Black spruce (*Picea mariana*)	1	0	None	No signs of browsing.



FALL FOODS (1936) — 21 STOMACHS

LATE WINTER FOODS (1936–37) — 51 STOMACHS

FIGURE 1.--Foods eaten by white-tailed deer in northeastern Minnesota, expressed in percentage by volume. A, Contents of 21 stomachs taken in the fall of 1936; B, contents of 51 stomachs taken late in the winter of 1936-37.

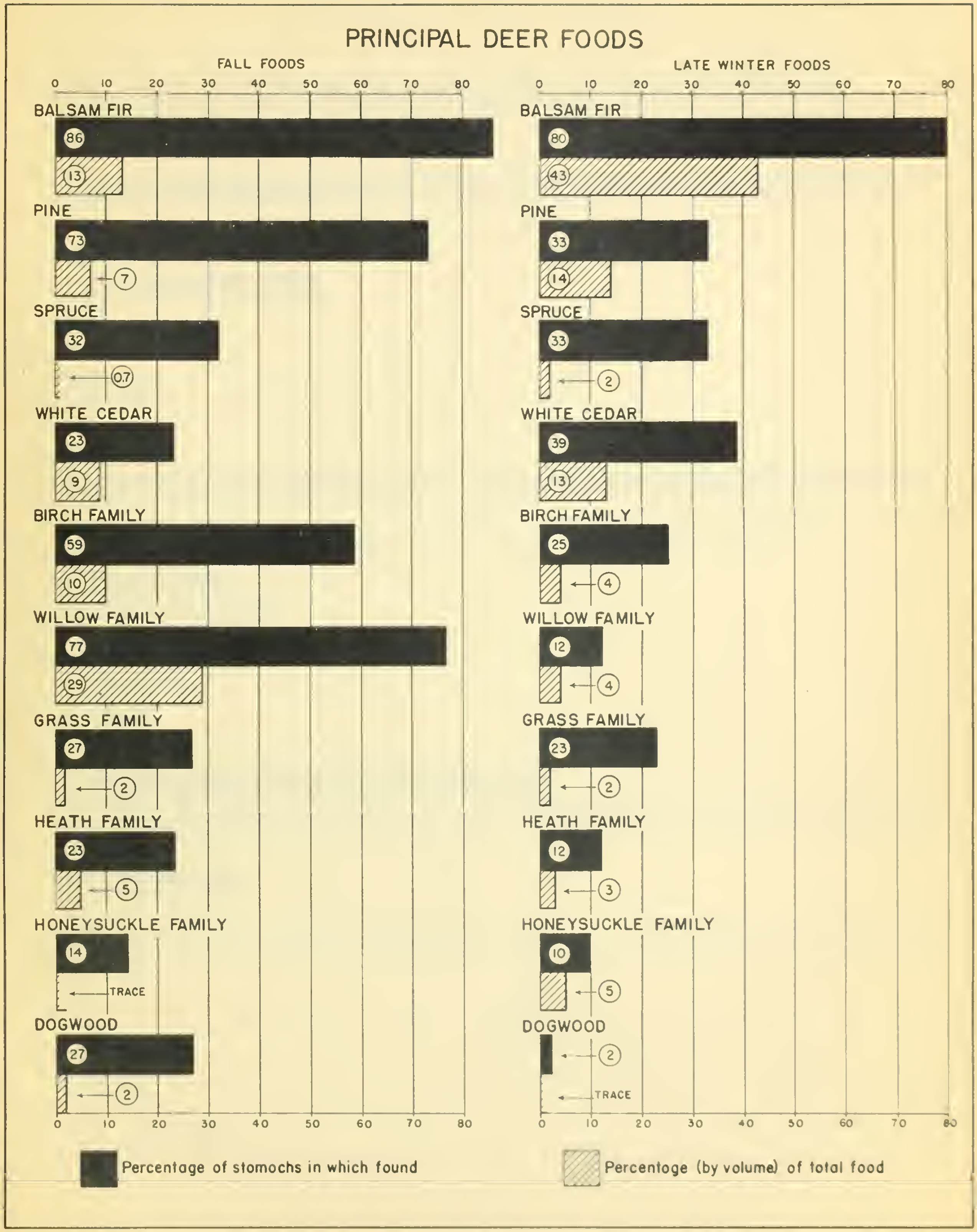


FIGURE 2.--Principal foods eaten by white-tailed deer in northeastern Minnesota, 1936-37.

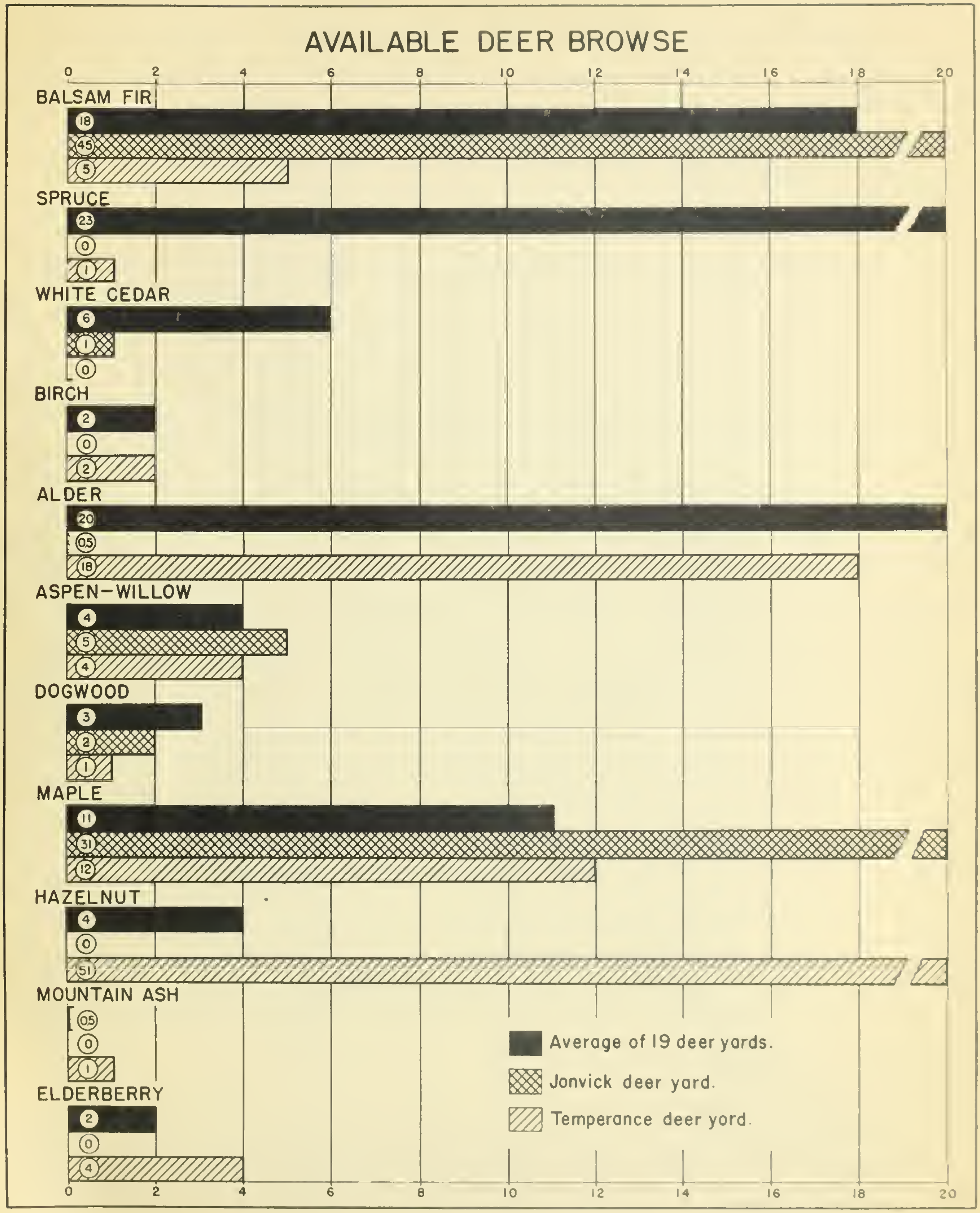


FIGURE 3.--Quantity of certain kinds of browse (expressed in percentage of total weight pounds) available to deer in the Superior National Forest, 1934-37.